

Biomedical engineers develop wearable respiration monitor with children's toy

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The paired sensors -- one placed between the ninth and 10th ribs and the other on the abdomen -- track the rate and volume of the wearer's respiration by measuring the local strain on the application areas. Credit: Josh Kim / UCI

Researchers at the University of California, Irvine have developed a

wearable, disposable respiration monitor that provides high-fidelity readings on a continuous basis. It's designed to help children with asthma and cystic fibrosis and others with chronic pulmonary conditions.

The inexpensively produced sensors were created by UCI biomedical engineers using the popular children's toy Shrinky Dinks, thin sheets of plastic that are painted or drawn on and then shrunk with heat.

Placed in two positions—one between the ninth and 10th ribs and another on the abdomen—the Band-Aid-like devices track the rate and volume of the wearer's respiration by measuring the local strain on the application areas. The information gleaned could, in the case of asthma, help warn of an oncoming attack.

"The current standard of care in respiration monitoring is a [pulmonary function test](#) that's often difficult to perform and limited in terms of the snapshot it provides of a patient's respiratory health—meaning problems can sometimes be missed," said Michael Chu, UCI graduate student researcher in biomedical engineering and lead author of a paper on the innovation published today in *npj Digital Medicine*. "Our new stretch sensors allow users to walk around and go about their lives while vital information on the health of their lungs is being collected."

The devices are made by applying a very thin layer of metal to a sheet of the plastic toy and then heat-shrinking it to cause corrugation. The film is then transferred to a soft, stretchy material—similar to small bandage—that can be adhered to a patient. Signals from embedded sensors can be transmitted via Bluetooth to be displayed on a smartphone app.

Michelle Khine, UCI professor of [biomedical engineering](#), in whose lab the devices were developed, said she was inspired to pursue the innovation after the birth of her son nine months ago. Complications

required the newborn to be confined to the [neonatal intensive care unit](#) hooked up to an array of machines supplying oxygen and monitoring his breathing.

"Despite having his whole tiny body covered in sensors, all the [hospital staff](#) could get was respiration rate information. If you looked at the vitals monitor, you'd see this waveform, so it looked like they were getting [respiration volume] information, but they weren't," Khine said. "I felt so helpless with my child just lying in this box. I wasn't allowed to carry him for eight days, so it was heartbreaking—but also frustrating to see all of these wires hooked up to him but not giving all the information we wanted."

She said those days in the hospital following the birth of her son were strongly motivating to her as a biomedical engineer: "I sent some pictures of him all wired up to my students, and I said, 'We have to be able to do better than this. This is 2018. It's insane.'"

Khine's lab is well-known for employing Shrinky Dinks as a platform for medical applications. About a decade ago, she innovated the use of the toy to produce microfluidic devices.

"It's amazing that this toy for kids has enabled us to create these robust sensors that may one day benefit children and others around the world," she said.

So far, members of the Khine lab have tested the new technology on healthy subjects, but there are plans for a pilot trial with a small number of asthma sufferers in the coming months.

More information: Michael Chu et al, Respiration rate and volume measurements using wearable strain sensors, *npj Digital Medicine* (2019). [DOI: 10.1038/s41746-019-0083-3](https://doi.org/10.1038/s41746-019-0083-3)

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